ROUTING SHEET

Document Title:	**GAMMA SPECTROSCOPY CALIBRATION PROCEDURE**
RP#:	**SLAC-I-760-2A39C-011**
Revision #:	**001**
Revision Date:	**October 16, 2006**
Document Author:	**Henry Brogonia**

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ES&H DIVISION
RADIATION PROTECTION (RP) DEPT.
SLAC-I-760-2A39C-011-R-001

GAMMA SPECTROSCOPY CALIBRATION PROCEDURE

RP Dept Document, RE # 012

Stanford
Linear
Accelerator Center

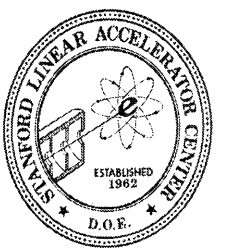

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TABLE OF REVISIONS

REVISION #	DATE	SECTION(S)	REASON FOR REVISION
001	October 16, 2006	All	Additional instructions for calibrating HPGe Gamma Spectroscopy systems

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1 PURPOSE

This procedure provides guidance for calibrating Gamma spectroscopy systems. Although there are several gamma spectroscopy systems used by the Radioanalysis Laboratory (Rad Lab), this procedure is applicable to High purity Germanium (HPGe) detectors and its associated electronics. Other gamma spectroscopy systems (ie. Sodium Iodide, SAM) may need additional instructions for operation. Please refer to their respective manuals for additional information.

2 REFERENCES

2.1 ORTEC GammaVision-32 Software User's Manual

2.2 ORTEC Solid State Photon Detector Operators Manual

2.3 Gamma Spectroscopy Analysis Procedure (SLAC-I-760-2A39C-009)

3 RESPONSIBILITIES

3.1 Rad Lab Operator

The Rad Lab Operator assigned to perform activities described in this chapter is responsible for:

- ensuring that prerequisites are met as required,
- reporting any problems or unexpected events to the Radiological Environmental Protection (REP) Manager,
- providing the calibration data to the REP Manager for analysis, approval, and
- Performing other duties assigned by the REP Manager.

3.2 REP Manager

The REP Manager is responsible for:

- ensuring that the activities in this chapter are conducted in accordance with this written procedure,
- assigning the tasks in this procedure to a qualified Operator, and

- providing final approval or disapproval of all data and submittals.

4 PREREQUISITES

4.1 Must be familiar with Windows operating menus.

4.2 Must have a basic understanding of Gamma Spectroscopy theory.

4.3 Must be familiar with general electronic equipment (NIMBins, Amplifiers, HV Power supplies, oscilloscopes)

4.4 Must be familiar with general laboratory equipment (pipettes, scales, etc.)

4.5 Must have experience with the Gammavision software.

5 PROCEDURES

5.1 Pre-Calibration

Obtain a copy of the HPGe Calibration Form and fill out sections 1A through 1E. A copy of the form is located on the V-drive under the following path: V:\ESH\OHP\DREP\RAD LAB\HPGe\Gammavision Shortcuts\HPGE Calibration Form.doc

Obtain the source standard to be used for calibration and a copy of its certificate. The standard used for calibration should have a valid certificate date and be NIST (National Institute of Standards and Technology) traceable. Fill out section 2A. Note: the calibration standard and the standard used for the QA check may be different.

Inspect all the cables and their connections for any signs of damage (corrosion at the connections, crumbling insulation, etc.). Also check the filter on the X-Cooler. Replace any missing or damaged parts. Fill out section 2B.

As part of the instrument quality control process, a QA check should be performed daily when the Gamma Spectroscopy system is in use. A daily QA check will allow the analyst to detect any drift within the system as well as well as assist in pinpointing any problems the system may have.

Perform a QA check as described in the Gamma Spectroscopy Analysis procedure (SLAC-I-760-2A39C-009). Verify that all the peaks fall within +/- 2 eV of the corresponding energies, and the activities listed on the source check report should also fall within 10% of the listed activities on the certificate. This is verified under the QA Status page. The status page will

indicate an “o.k.” next to each QA parameter if it falls within satisfactory limits. If the system is operating within the limits, then no electronic adjustment is needed. Fill out section 2C. Note the previous electronic settings and also copy them as the new settings on the form (Section 3A). Proceed to section 5.5 of this procedure to perform the energy calibration.

If the QA check indicates a need for electronic adjustment, make sure that the electronic settings have not changed since the last calibration. Retrieve the latest calibration report and assure that the electronic settings such as gain, shaping time, and ADC conversion are all intact. Depending on the system, the electronic settings must be changed through the Gammavision software or through the hardware unit (NimBin, NOMAD, etc). If the electronic settings do not match, restore the original settings. Rerun the QA check. View the QA status page. If the system fails under the settings from the last calibration, fill out section 2C on the form. Note the previous settings in section 3A of the form and continue to section 5.3 of this procedure to perform the coarse calibrations. If the system passes under the old electronic settings fill out sections 2C of the form. Note the previous settings in section 3A of the form, copy them as the new settings, and skip to section 5.5 of this procedure to perform the energy calibration.

5.3 Coarse calibration and initial electronic settings

Note the Polarity, shaping time, and High Voltage on the form (Section 3A). Unless you are setting up a new system or different detector/electronics configuration, these parameters should never change between calibrations. The previous and new settings should be the same. Consult the REP manager or the vendor when setting up a new system or detector configuration.

The energy to channel ratio must be determined prior to starting the coarse calibration. The Rad Lab currently uses a 1:2 energy/channel ratio, meaning that each channel number should be twice as its corresponding energy in keV. For instance a 511 keV peak should fall under channel 1022. The calibration procedure is also written using this ratio. **Note: If an energy/channel ratio is chosen other than 1:2, the channels referenced in this procedure will not apply.** For ratios other than 1:2, refer to the detector manual for information on calibrating the system.

Place a Cobalt-60 (Co-60) source on the detector and initiate the counting process. Continue counting until the Co-60 peaks are defined. Adjust the coarse gain until the two Co-60 peaks fall within a 1-5 channels of the corresponding energies (1173 and 1332 keV). The peak energies do not have to exactly match the corresponding channels, but make sure that the channel separation between the peaks is 318 channels. Once this is complete note

the coarse gain and conversion gain on the form (Section 3A). Proceed to section 5.4 of this procedure to perform the Fine Calibration

5.4 Fine Calibration

Reset the counting display. Initiate another count until the Co-60 peaks are defined. Adjust the fine gain until the Co-60 peaks are within corresponding channels 2346 and 2664. If necessary the zero offset setting may be adjusted until the peaks line up. The fine calibration may take several iterations before the desired settings are reached.

Once the settings are satisfactory, remove the Co-60 source and note the fine gain and zero offset (Section 3A) on the form. Proceed to Section 5.5 of this procedure to perform the energy calibration.

5.5 Energy Calibration

Obtain a certified multinuclide source standard. The source standard should represent a matrix similar to Rad Lab samples and have several nuclides with gamma energy peaks between 0-2000 keV. Verify (by certificate) that these nuclides are still present within the standard. If there are not enough peaks to represent the 0-2000 keV range, another source standard must be obtained. Attach any standard certificates used in the calibrations to the calibration report.

Place the standard on the detector and initiate a counting process until the peaks are well defined and have good statistics. A good rule of thumb is to make sure to have at least 10,000 counts for each peak. Depending on the activities in the source standard, this may take hours or a few days. Save the spectrum. Note the count time and spectrum file name on the form under section 3B.

Open the energy calibration section of the software, highlight each peak and enter its corresponding energy as listed on the standard certificate. For instance, enter 1173 keV for the Co-60 peak near channel 2364. Repeat for all energy peaks of the standard. An energy curve should develop as all the points are entered. Make sure the energy curve is linear and that all points are within 1% of the curve. If a point does not fall within 1% of the line, remove it. Once the energy curve is established, save the file and note the filename on the calibration form (3B). Refer to Gammavision software manual for specific details on performing an energy calibration.

5.4 Efficiency Calibration

Using spectrum used for energy calibration open the efficiency calibration section of the software. Enter the corresponding activities for each peak as listed on the standard certificate. Remove any points that do not fall within 5% of the calibration curve. Verify that the general shape of the curve is similar to the efficiency curve of the last calibration. Save the efficiency calibration and note the file name on the calibration form (3B). Refer to the Gammavision software manual for specific details on performing an efficiency calibration.

5.5 Final Calibration Verification

Once the Energy and Efficiency calibrations are performed save the final calibration and note its filename. This is done by selecting [Calibrate] and [Save Calibration] under the Gammavision top menu. Print a calibration record by selecting [Calibration] and [Print Calibration] and attach to the calibration report.

Perform a count as described in the Gamma Spectroscopy Analysis procedure (SLAC-I-760-2A39C-009). Use the same source standard used in the calibration. Verify that the energies and activities reported in the analysis are the same as the standard certificate. Note the results in section 3B of the form.

The calibration performed is only good for the same sample matrix and size. Additional calibrations may need to be performed for other samples. The Rad Lab currently runs a 500ml liquid calibration and a 250ml soil calibration. For each additional calibration, only the energy and efficiency calibrations need to be performed.

5.6 Approvals

Once the entire calibration process is complete sign the form under section 4 and obtain approvals.

6 RECORDS

6.1 All calibration results generated from this procedure should be entered into a calibration report and submitted to the REP manager for approval.

6.2 All hardcopies of the Analysis reports generated from this procedure, including the calibration report, standard certificate, and calibration printout should also be provided and stored in the Rad Lab archives. An electronic copy should also be stored in the REP/Rad Lab V-Drive.

7 ATTACHMENTS/FORMS

7.1 Attachment 1: Gamma Spectroscopy calibration report

7.1 Attachment 1: Gamma Spectroscopy calibration report

Gamma Spectroscopy Calibration Form

For instructions see the Gamma Spectroscopy Calibration Procedure SLAC-I-760-2A39C-009

Section 1. System Information

A. Calibration Date: 10/4/2006

B. System Type: ☑ Laboratory ☐ Portable ☐ Other:_____

C. Detector Serial Number: 34-TN30919A (PREAMP S/N #4448)

D. Detector Type: ~~☑ P-Type~~ HB ☑ N-Type

E. Electronics: ☐ DSPEC ☑ NimBin ☐ Other:_____

Section 2. Pre-Calibration

A. Source Standard Information:

Mixed Gamma Matrix: ☐ Epoxy ☑ Soil ☐ Other_____

Matrix Volume/Weight: 425.8 g / 250 ml

Serial Number: 1199-87-3

Certificate Date: 9/1/06 (EXPIRES 9/1/07)

B. Equipment check:

Cable Insulation:	☑ Pass	☐ Fail
Cable Connections:	☑ Pass	☐ Fail
Corrosion:	☑ Pass	☐ Fail
Filter (X-Cooler):	☑ Pass	☐ Fail

C. QA Check:

Background:	☑ Pass	☐ Fail
Total Activity:	☑ Pass	☐ Fail
Peak Shift:	☑ Pass	☐ Fail
Av. FWHM Ratio:	☑ Pass	☐ Fail

D. Electronic Adjustment Needed? ☐ Yes ☑ No

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Page 1 of 3

Gamma Spectroscopy Calibration Form

Section 3. System Settings

A. Electronic Settings

	Previous Settings:	New Settings:
Energy/Channel Ratio:	1:2	SAME AS OLD
HV:	3500 kV	↓
Polarity:	NEG	↓
Coarse Gain:	100	↓
Fine Gain:	1.24	↓
Conversion Gain:	4K	↓
Shaping Time:	6µS	↓
Zero Offset:	0.14	↓

B. Software Settings

Spectrum File Name: Cal Spec NEW Soil 2006.Spc

Count Time: 6342 seconds

Energy Calibration Filename: Cal Spec NEW Soil 2006.Ent

Efficiency Calibration Filename: Cal Spec NEW Soil 2006.Eff

Calibration Filename: NimCa\Soil2006B.Clb

Final Verification Count: ☑ Pass ☐ Fail

Section 4. Approvals

Performed by:

COPY
Print name

Signature

Date

Approved by:

COPY
Print name

Signature

Date

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Page 2 of 3

Gamma Spectroscopy Calibration Form

Section 5. Attachments

Attachment 1:	Source Standard Certificate(s)
Attachment 2:	Efficiency/Energy Calibration Printout
Attachment 3:	Verification Report

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
MULTINUCLIDE STANDARD SOURCE

Customer: STANFORD LINEAR ACCELERATOR CENTER
P.O. No.: 64518
Catalog No.: EG-ML

Source No.: 1199-87-3
Reference Date: 1-Sep-06 12:00 PST
Contained Radioactivity: 2.598 µCi 96.13 kBq

Physical Description:

A. Capsule type: 500mL Nalgene bottle
B. Nature of active deposit: Multinuclide distributed in 1.7 g/cc sand matrix
C. Active diameter/volume: Approximately 250mL (425.8 grams)
D. Backing: Plastic
E. Cover: Plastic

Gamma-Ray Energy (keV)	Nuclide	Half-life	Branching Ratio (%)	Activity (µCi)	Gammas per second	Total Uncert.
60	Am-241	432.17 ± 0.66 years	36.0	0.07293	971.4	3.1 %
88	Cd-109	462.6 ± 0.7 days	3.63	0.7193	966.1	3.1 %
122	Co-57	271.79 ± 0.09 days	85.6	0.02814	891.3	3.1 %
159	Te-123m	119.7 ± 0.1 days	84.0	0.03515	1092	3.1 %
320	Cr-51	27.706 ± 0.007 days	9.86	0.9024	3292	3.0 %
392	Sn-113	115.09 ± 0.04 days	64.9	0.1405	3374	3.0 %
514	Sr-85	64.849 ± 0.004 days	98.4	0.1687	6142	3.0 %
662	Cs-137	30.17 ± 0.16 years	85.1	0.1132	3564	3.0 %
898	Y-88	106.630 ± 0.025 days	94.0	0.2758	9592	3.0 %
1173	Co-60	5.272 ± 0.001 years	99.86	0.1417	5236	3.0 %
1333	Co-60	5.272 ± 0.001 years	99.98	0.1417	5242	3.0 %
1836	Y-88	106.630 ± 0.025 days	99.4	0.2758	10140	3.0 %

Method of Calibration:

This source was prepared from weighed aliquots of solutions whose concentrations in µCi/g were determined by gamma spectrometry.

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- Overall uncertainty is calculated at the 99% confidence level.
- This source has a working life of 1 year.

Daniel James Van Dalsem
Quality Control

14-Sep-06
Date

IPL Ref. No.: 1199-87

ISO 9001 CERTIFIED

Medical Imaging Laboratory

Industrial Gauging Laboratory

Calibration Data from file: NimCalSoil2006B.Clb
Energy Calibration Date: 5/24/2006 Time: 1:05:20 PM
Efficiency Calibration Date: 5/24/2006 Time: 1:09:35 PM

Calibration Description:
Calibration of NimBin HPGe Detector with IPL Epoxy source SN 104
6-67-2. Standard counted for 12027 sec with bottle on detector

Energy Calibration Fit
Energy = -0.3324 +0.500640*Channel -1.00434e-007*Channel**2
FWHM (keV) = 2.5409 +0.000888*Channel -1.42471e-008*Channel**2

Energy/FWHM Table

Channel	Energy(keV)	Fit(keV)	Delta	FWHM	Fit	Delta
119.55	59.54	59.52	0.04%	1.36	1.33	2.27%
176.44	88.03	88.00	0.04%	1.37	1.35	1.16%
244.42	122.07	122.03	0.03%	1.35	1.38	-1.97%
332.02	165.85	165.88	-0.02%	1.39	1.42	-1.92%
783.27	391.69	391.74	-0.01%	1.57	1.62	-2.85%
1322.91	661.66	661.79	-0.02%	1.93	1.85	4.46%
1794.99	898.02	897.99	0.00%	2.04	2.05	-0.49%
2345.16	1173.24	1173.19	0.00%	2.28	2.27	0.11%
2663.50	1332.50	1332.41	0.01%	2.36	2.40	-1.77%
3670.81	1836.01	1836.07	-0.00%	2.82	2.80	0.51%

Efficiency Calibration Fit
Polynomial Uncertainty = 2.9459 %
Coefficients:
-0.551778 -4.121626 -0.130861 0.051441 -0.004501 0.000117

Efficiency Table

Energy	Efficiency	Fit	Delta
59.24	2.1362E-002	2.1356E-002	0.03%
87.78	2.5483E-002	2.5550E-002	-0.26%
121.82	2.3538E-002	2.3406E-002	0.56%
391.61	1.1724E-002	1.2199E-002	-4.05%
661.34	1.1152E-002	1.0237E-002	8.20%
1173.12	7.5126E-003	7.8611E-003	-4.64%
1332.16	6.9797E-003	7.2425E-003	-3.76%
1835.66	5.7528E-003	5.5651E-003	3.26%

Calibration Certificate Table

Isotope	Energy	Pct	Halflife	Activity	GPS	Error	Date & Time
Am-241	59.24	36.30	1.58E+005	2640.22	958.40	3.10%	5/15/2004 12:00:00 PM
Cd-109	87.78	3.61	4.63E+002	38393.35	1386.00	3.00%	5/15/2004 12:00:00 PM
Co-57	121.82	85.60	2.72E+002	1370.33	1173.00	3.00%	5/15/2004 12:00:00 PM
Sn-113	391.61	64.16	1.15E+002	6851.62	4396.00	3.00%	5/15/2004 12:00:00 PM
Cs-137	661.34	85.21	1.10E+004	5971.13	5088.00	3.00%	5/15/2004 12:00:00 PM
Co-60	1173.12	99.90	1.93E+003	7230.23	7223.00	3.00%	5/15/2004 12:00:00 PM
Co-60	1332.16	99.98	1.93E+003	7233.30	7232.00	3.00%	5/15/2004 12:00:00 PM
Y-88	1835.66	99.35	1.07E+002	13749.37	13660.00	3.00%	5/15/2004 12:00:00 PM

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                                Cal Spec NEW Soil 2006

     ORTEC g v - i (1087) wan32  G53W2.06  15-NOV-2006 15:23:31 Page    1
Stanford Linear Accelerator Ce  Spectrum name: Cal Spec NEW Soil 2006.An1

Sample description
     New Soil Standard Calibration File


Spectrum Filename: C:\User\Cal Spec NEW Soil 2006.An1

Acquisition information
       Start time:                 04-Oct-2006 14:23:07
       Live time:                6342
       Real time:                6734
       Dead time:                   5.83 %
       Detector ID:                    1

Detector system
     MATC-122


Calibration
       Filename:                   NewNimCalSoil2006.Clb
     Calibration of NimBin HPGe Detector with IPL Soil source. Standa
     rd counted for 6341 sec with bottle on detector

       Energy Calibration
            Created:               05-Oct-2006 07:47:25
            Zero offset:          -0.315 keV
            Gain:                  0.501 keV/channel
            Quadratic:            -7.285E-08 keV/channel^2

       Efficiency Calibration
            Created:               05-Oct-2006 07:52:11
            Type:                  Polynomial
            Uncertainty:           2.203 %
            Coefficients:         -0.272752  -4.963240   0.489552
                                  -0.067023   0.004115  -0.000097

Library Files
       Main analysis library:      NewSoilCal.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:             wan32   G53W2.06
       Start channel:             100 (    49.75keV )
       Stop channel:             4000 (  2001.19keV )
       Peak rejection level:       50.000%
       Peak search sensitivity:    2
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Currie limit

       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           average of three points.

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Cal Spec NEW Soil 2006
ORTEC g v - i (1087) wan32 G53W2.06 15-NOV-2006 15:23:31 Page 2
Stanford Linear Accelerator Ce Spectrum name: Cal Spec NEW Soil 2006.An1

Half lives decay limit: 12.000
Activity range factor: 2.000
Min. step backg. energy 0.000

Corrections	Status	Comments
Decay correct to date:	YES	01-Sep-2006 12:00:00
Decay during acquisition:	NO	
Decay during collection:	NO	
True coincidence correction:	NO	
Peaked background correction:	NO	
Absorption (Internal):	NO	
Geometry correction:	NO	
Random summing:	NO	

Energy Calibration
Normalized diff: 1.0000

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 2 Sigma %	FWHM keV	Suspected Nuclide	
145.54	72.53	101649.	2044.	0.322	44.34	1.421	BI-207	D
149.97	74.75	114676.	4187.	0.660	23.09	1.423	TL-208	D
273.25	136.48	113514.	16058.	2.532	7.24	1.449	CO-57	
372.81	186.33	103318.	2170.	0.342	50.04	2.505	PA-234	s
510.49	255.25	94950.	11147.	1.758	10.02	1.571	SN-113	s
1252.63	626.72	32766.	662.	0.104	95.04	0.769	W-187	s
1489.75	745.39	20095.	503.	0.079	92.47	1.073	AG-110M	s
1626.57	813.99	23082.	4383.	0.691	10.26	1.996	J-132	D
1823.34	912.33	25965.	854.	0.135	69.26	1.593	AC-228	s
2068.01	1034.76	21352.	576.	0.091	95.37	0.510	SB-126	s
2291.49	1146.26	9522.	319.	0.050	87.34	2.223	TE-131	D
2646.80	1324.62	14033.	7001.	1.104	5.35	2.336	KR-89	D
2840.27	1421.13	10590.	406.	0.064	95.36	1.483	-	s
2917.50	1459.76	10631.	490.	0.077	77.31	1.071	AC-228	s
2987.27	1494.66	10532.	445.	0.070	82.66	0.957	AC-228	s
3394.18	1698.63	5532.	260.	0.041	82.01	2.557	PA-234	D
3700.06	1851.19	3777.	539.	0.085	46.41	2.642	XE-138	

s - Peak fails shape tests.
D - Peak area deconvoluted.

This section based on library: NewSoilCal.Lib

ORTEC g v - i (1087) wan32 G53W2.06 15-NOV-2006 15:23:31 Page 3
Stanford Linear Accelerator Ce Spectrum name: Cal Spec NEW Soil 2006.An1

********** I D E N T I F I E D P E A K S U M M A R Y **********

Nuclide	Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 2 Sigma %	FWHM keV
AM-241	119.35	59.44	175938.	140274.	22.120	1.24	1.443s
CD-109	176.44	88.02	198715.	163103.	25.720	1.14	1.439s
CO-57	244.60	122.14	175462.	148352.	23.394	1.18	1.486s

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Te-123	318.38	159.08	185017.	148804.	23.465	1.24	1.529s
CR-51	640.29	320.23	122243.	160850.	25.364	1.02	1.654s
SN-113	783.33	391.83	96203.	270470.	42.650	0.61	1.706s
Sr-85	1027.61	514.10	88081.	357233.	56.332	0.49	1.806s
CS-137	1322.65	661.77	77062.	259256.	40.882	0.61	1.888s
Y-88	1794.84	898.07	55696.	437092.	68.925	0.39	2.100s
CO-60	2344.65	1173.18	31766.	245080.	38.646	0.53	2.213s
CO-60	2663.11	1332.50	26203.	208294.	32.846	0.49	2.341D
Y-88	3669.94	1836.12	9202.	292013.	46.047	0.40	2.649s

s - Peak fails shape tests.
D - Peak area deconvoluted.
A Derived peak area.

***** SUMMARY OF LIBRARY PEAK USAGE *****

Nuclide Name	Code	Average Activity microCi	Peak Energy keV	Peak Activity microCi	Code	MDA Value microCi	Comments
CD-109		7.4138E-01	88.03	7.414E-01	*(	3.333E-03	G
CO-57		2.8603E-02	122.07	2.860E-02	*(	1.329E-04	G
CO-60		1.4212E-01	1173.24	1.421E-01	@(	1.700E-04	G
			1332.50	1.312E-01	-	5.016E-04	G
CS-137		1.2188E-01	661.66	1.219E-01	*(	2.147E-04	G
Sr-85		1.2301E-01	514.00	1.230E-01	*(	1.681E-04	G
SN-113		1.1894E-01	391.69	1.189E-01	*(	2.244E-04	G
Y-88		2.2777E-01	1836.01	2.309E-01	@(	1.248E-04	G
			898.02	2.245E-01	*(	1.994E-04	G
Te-123		3.0723E-02	159.00	3.072E-02	*(	1.461E-04	G
CR-51		4.0387E-01	320.07	4.039E-01	*(	1.444E-03	G

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Stanford Linear Accelerator Ce Spectrum name: Cal Spec NEW Soil 2006.An1

Nuclide	Ave activity	Energy	Activity	Code	Peak MDA	Comments
AM-241	7.7582E-02	59.54	7.758E-02	*(	3.816E-04	G

(- This peak used in the nuclide activity average.

* - Peak is too wide, but only one peak in library.
! - Peak is part of a multiplet and this area went negative during deconvolution.
? - Peak is too narrow.
@ - Peak is too wide at FW25M, but ok at FWHM.
% - Peak fails sensitivity test.
$ - Peak identified, but first peak of this nuclide failed one or more qualification tests.
\+ - Peak activity higher than counting uncertainty range.
\- - Peak activity lower than counting uncertainty range.
= - Peak outside analysis energy range.
& - Calculated peak centroid is not close enough to the library energy centroid for positive identification.

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P - Peakbackground subtraction
} - Peak is too close to another for the activity
to be found directly.

Nuclide Codes:
T - Thermal Neutron Activation
F - Fast Neutron Activation
I - Fission Product
N - Naturally Occurring Isotope
P - Photon Reaction
C - Charged Particle Reaction
M - No MDA Calculation
R - Coincidence Corrected
H - Halflife limit exceeded

Peak Codes:
G - Gamma Ray
X - X-Ray
P - Positron Decay
S - Single-Escape
D - Double-Escape
K - Key Line
A - Not in Average
C - Coincidence Peak

- -

***** SUMMARY OF NUCLIDES IN SAMPLE *****

Nuclide	Time of Count Activity uCi	Time Corrected Activity uCi	Uncertainty Counting uCi	2 Sigma Total uCi
CD-109 #	7.4138E-01	7.7907E-01	8.8520E-03	3.7213E-02
CO-57 #	2.8603E-02	3.1123E-02	3.6637E-04	1.4439E-03
CO-60	1.4212E-01	1.4383E-01	7.6047E-04	5.0000E-03
CS-137 #	1.2188E-01	1.2213E-01	7.4886E-04	4.3600E-03
Sr-85 #	1.2301E-01	1.7522E-01	8.5157E-04	6.0801E-03
SN-113 #	1.1894E-01	1.4518E-01	8.7957E-04	7.1969E-03
Y-88 #	2.2777E-01	2.8245E-01	7.9308E-04	9.7843E-03
Te-123 #	3.0723E-02	3.7214E-02	4.6332E-04	1.7331E-03
CR-51 #	4.0387E-01	9.2460E-01	9.4116E-03	4.2546E-02
AM-241 #	7.7582E-02	7.7594E-02	9.6195E-04	3.6125E-03

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Stanford Linear Accelerator Ce Spectrum name: Cal Spec NEW Soil 2006.An1

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- SUMMARY ----------

Total Activity (49.8 to 2001.2 keV) 2.0158813E+00 uCi
Total Decayed Activity (49.8 to 2001.2 keV) 2.7184112E+00 uCi

Analyzed by: _____
Brogonia

Reviewed by: _____
Supervisor

Laboratory: Stanford Linear Accelerator Center

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